ESTIMATION OF GREEN HOUSE GAS FROM THE SEWAGE TREATMENT PLANT IN DEHRADUN AND UTTARKASHI

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Abstract- As we know the greenhouse gas such as methane and the carbon dioxide are very harmful for our environment and as concerned with the treatment plant it can also release a greenhouse gas which is very harmful for our environment so for that the calculation of these gasses is done with respect to different sewage treatment unit and present a conclusion of using a sewage treatment plant that release the low amount of gas and these calculation is done separately for both the treatment plant and in different days over a month. So the further the area that is selected a description is given. The study area includes two sites one is in the hill area and other is in the Dehradun and other is in Uttarkashi these both district is in uttarakhand. Dehradun is located at 20.3165-degree N and 78.0322-degree E. and Uttarkashi at 30.7268-degree N, 78.4354 degree E. In Uttarkashi there is a aerobic treatment unit MBBR which is 2 MLD and in Dehradun there is 17 MLD SBR technique which is used to treat the waste water on daily basis. the BOD removal efficiency of MBBR is 90 to 95% at low rate and 75 to 80% for high rate and a sequencing batch reactor (SBR), having capacity of 20 MLD have been provided at Mothrowala Dehradun. And these sewage treatment plant are small as compared to other in carbon footprint and the treatment of sludge is create problem of environment pollution.

Keywords**:** Greenhouse Gas (GHG), Sequencing Batch Reactor (SBR), Moving Bed Biofilm Reactor (MBBR), Global warming potential(GWP),Intergovernmental Panel on Climate Change (IPCC).

INTRODUCTION

Definition of GHG

Foul gases in the environment which release due to human activity such as Chlorofluorocarbon. The aggregate sum of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) dischargefrom sewage treatment plant. the carbon dioxide global warming potential(GWP) also plays an important role. And the significant ozone harming substances are the carbon dioxide, methane, and nitrous oxide (N_2O). The carbon emission from the waste water treatment plant is not been consider a prominent source of the greenhouse gasses. but if we talk about the presence of CO_2 and the CH_4 that release from the waste water treatment plant plays and major role as their maximum amount of waste water treatment plant is available. The estimation and the evaluation of these gasses can be done with the present scenario. The emission of GHG includes the emission of green house gasses from the wastewater treatment which release CO_2due to the de-nitrification. And the release of methane and nitrous oxides from the anaerobic digestion of sludge in the process. Apart from all these the transportation also cost to release the greenhouse gasses.

Carbon credit conspire in wastewater Treatment

In the current situation, an unnatural weather change and environmental change is being considered as the worldwide issue and a large number of the examinations have present concerning wastewater treatment that impacts the biological system. Nevertheless, when slime created from the wastewater treatment unit is processed on the site, at that point additional measure of CO_2 and CH_4 emanation happens. De-nitrification and nitrification process for the most part discharge the N_2O or additionally from a treatment and we characterize the dangerous atmospheric deviation capability of a GHG is characterized as the measure of warmth caught by one unit of CO_2over a specific timeframe (approx. 100 years). For N_2O it is 310 kg proportional CO_2 and for CH_4 it is 21. On the off chance that a little amount of GHG discharged with high potential will greater affect the environment when contrasted with green house gas with low global warming potential.

Universal Green house gas emission

If we look through the universal green house gas emission the global warming potential helps us to relate that how much heat is entrapped by a particle of several green house gas according to Indian standards methane has approx16% and nitrous oxide about 6%and other gases about 2%. The ozone harming substance discharge from the financial division and the other area according to IPCC 2014 dependent on worldwide emanation from 2010 and appeared in fig.2. in the event that we glance through all out emanation of GHG 25% if from power and warmth creation, 24% is from ranger service and other land utilize 6% from building ,14% from transportation ,21%is from enterprises and staying 10% from the other wellspring of vitality. Regularly the outflow of CO_2 from squander water treatment plant isn't considered however bookkeeping the ozone depleting substance emanation as it is biogenic birthplace. 18.1% of CH4 and N20 discharge is happen from the waste removal and treatment. Furthermore, in an equivalent example the all out discharge of N2O, 2.3% is from squander treatment and removal.

Global CO_2 emission trend: 2014 Report

Out of 6 biggest CO_2 discharging nations, conspicuous pattern have been found in the best 3 CO_2 radiating nations, which represent 55% of all out worldwide of CO_2emission in 2011[4].the biggest CO_2emitting nation is china, which was 28% of the complete outflow of co_2 in 2011 which is been the higher than the second biggest transmitting nation US of America , with 16% and the European association with the 10% and India comprise 6 of Japan , 4% appeared in fig3.india was referenced 4[th] biggest CO_2 emanating nation in 2011 and a aggregate sum of 2.1 billion tones. As the populace is expanding step by step this will cause a tremendous measure of emanation. There are various components which affected the yield of residential waste water in urban zones. As we know the financial improvement of nation depends on the GDP of nations
.as the monetary movement or the GDP expands it will cause the expansion in residential waste water and COD release evacuation and it is been seen that the amount of waste water gushing develops every year with a stable GDP development and this amount of waste water shows a direct relationship with GDP . This pattern is appeared in table 1

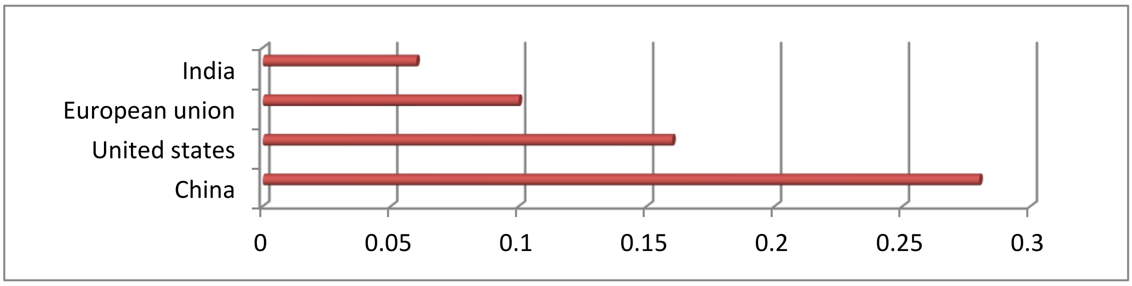

Figure3 .Natural CO2 emission source by IPCC(2014) on the global emission in 2010 and 2011

Table 1.variation in the GDP% emission in 2013

country	Shares of national GDP(%) on PPP basis	% co_2 , global emission	Co_2 emission in billion tones	Per capita co_2 emission in tones
china	15	29	10.3	7.40
USA	16	15	5.3	16.6
EU28	17	11	3.70	7.3
India	7	6	4.30	1.7
Russia	3	5	1.80	12.6
japan	3	4	1.40	10.7

Table 2. Emission from different sector

Activity	Ch_4	N_2O	Co_2, Equiv.
Domestics	861	15.8	22,979
Industries	1050	-	22,050
overall	1911	15.8	45,029

Global warming potential of GHG

The global warming potential is defined by the amount of heat entrapped by the one unit mass of molecule of CO_2 as compared to the other molecule like CO_2 and N_2O. This gap depends upon the type of gas we are dealing with therefore little amount of gas which was released with a high GWP can affect higher than the gas with low GWP .for example the heat which was emitted by 1 molecule of N_2O is equal to 310kg of CO_2. And the global warming potential of chg. produced from wastewater treatment plant according to IPCC , 2001, Research Triangle Institute, 2010(USEPA) has been given in table 3.
The CHG emission takes place onsite as well as offsite. On site sources include other process as well as the combustion of fuel of the generation of energy. The offsite include the generation of electricity chemical for offsite and also the land filling and the transportation and disposal.

Table 3 .potential of global warming of GHG

GHG	Chemical formula	Life time (Yr).	Global warming potential for given time horizon (100years)

Carbon di oxide	Co_2	100	1	1
methane	CH_4	12	23	21
Nitrous oxide	N_2O	114	296	310

Study Area and site Description

The study area includes two sites one is in the hill area and other is in the Dehradun and other is in Uttarkashi these both district is Uttarakhand. Dehradun is located at 20.3165 degree N and 78.0322 degree E. and Uttarkashi at 30.7268 degree N, 78.4354 degree E. in Uttarkashi there is a aerobic treatment unit MBBR which is 2 MLD and in Dehradun there is 20MLDld SBR technique which is used to treat the waste water on daily basis .the BOD removal efficiency of MBBR is 90 to 95% at low rate and 75 to 80% for high rate and a sequencing batch reactor (SBR) , having load capacity 20 MLD it is located at Mothrowala Dehradun .these are the small treatment plant having low carbon emission. The treatment of sludge and its concern pollution in the environment but also considered important in reducing the amount of emission of the greenhouse gases the both the treatment unit of Uttarkashi and Dehradun site are shown in below.

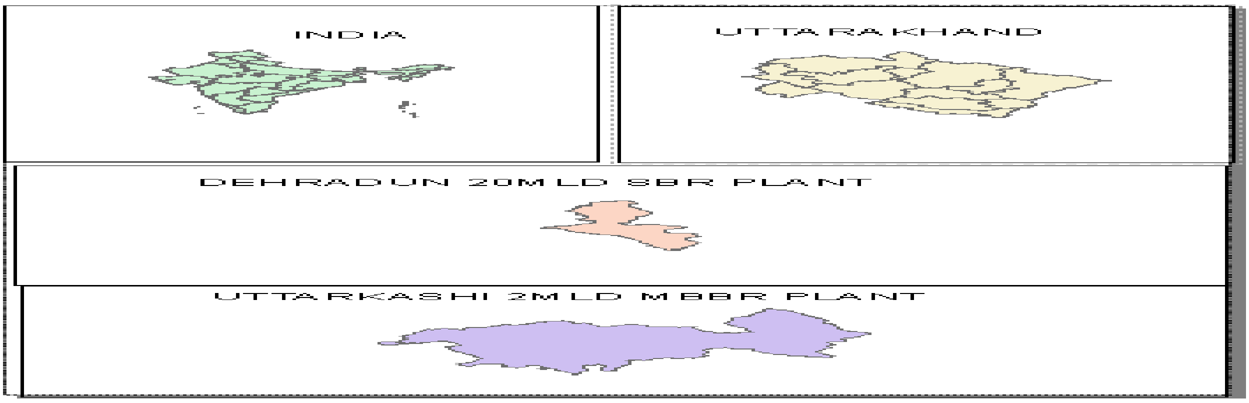

Figure 4 map on study area at Uttarkashi and Dehradun

Objective of study

- estimate the release of CO_2 and CH_4 from waste water treatment plant
- To calculate the values of different physical parameter of wastewater inlet and outlet
- To select the best treatment unit by comparing SBR and MBBR..
- TO calculate the values of GHG separate for the wastewater and the sludge in $mgCO_2e$/year

Sequencing batch reactor (SBR)

This treatment process is used to treat the wastewater biologically in municipal and industrial. as there are many variation exist and this is activated sludge process and all the reaction take place in the single tank aeration and sedimentation and decanting .It takes much time to treat water but it does not take the much space .

Moving bed bio film reactor (MBBR)

It is most commonly used method which works biologically and treats the wastewater and this is used in municipal as well as industrial process. It was invented in the 1980s. MBBR offer an economical solution for wastewater treatment. STP MBBR technology is the use of a moving bed bio film reactor in sewage treatment plants. MBBR wastewater treatment system enables efficient results of the disposal using low energy. The technology is used to separate organic substances, nitrification and de-nitrification. MBBR design is made of an activated sludge aeration system. The sludge is collected on the plastic carriers which have large internal surface area. The surface area in the carriers optimizes the contact of water, air, and the bacteria

Calculation of GHG in the treatment plant

The calculation of green house gas is done by the certain formula which is used from the Indian standards as the formula used by the IPCC and the Research triangle institute for the calculation of the green house gas and that is to be further used in this and the calculation is done in the Dehradun district and Uttarkashi district and further these formula are explained below and the calculation is done on the basis of these formula given by the standard units

Calculation of methane and carbon dioxide

The calculation of the methane and carbon dioxide is done by the formula that is given below and there are some constant values that is to be used

$CO_2 = 10^{-6} \times Q_{WW} \times OD \times Eff_{OD} \times CF_{CO_2} \times [(1-MCF_{WW} \times BG_{CH_4})(1-\lambda)]$…... (3.1)

$CH_4 = 10^{-6} \times Q_{WW} \times OD \times Eff_{OD} \times CF_{CH_4} \times [(MCF_{WW} \times BG_{CH_4})(1-\lambda)]$ ……(3.2)

By using this equation we can calculate the biomass yield but there is some constant values that is been given and used .

$\lambda = \underline{Q_S*MLVSS_S}*CF_S$…………………………………….… (3.3)

QWW*OD*Effod*CFc

Calculating CH_4 and CO_2 emission from the sludge

As we are using the equation from which we have to calculate the emission of carbon di oxide and the methane as follows. The only solids entering the device for most sludge digesters are those produced in the waste water treatment system and the following equation can be used in this case to calculate the emission of sludge digester based on the wastewater treatment process feed

$CO_2 = 10^{-6}$ X Q_{WW} X OD X Eff_{OD} X CF_{CO_2} X [λ (1-MCFsX BG_{CH_4})]………… (3.4)

$CH_4 = = 10^{-6}$ X Q_{WW} X OD X Eff_{OD} X CF_{CH_4} X [λ (MCFsX BG_{CH_4})]………… (3.5)

As,

CO_2=CO_2 release rate (Milligram CO_2/hour);

CH_4= CH_4 release rate (Milligram CH_4/hour) ;

Q_{WW} =Wastewater coming flow rate (m^3 /hour);

OD =Oxygen demand of coming waste water as biological treatment unit be evaluated as either; BOD_5 or COD (mg/L = g/m^3);

Eff_{OD}= Oxygen demand removal efficiency of the biological treatment unit;

CF_{CO_2} = changing factor for maximum CO_2 generation per unit of oxygen demand; CF_{CH_4} = Changing factor for maximum CH_4 generation per unit of oxygen demand;

MCF_{WW} = Methane correction factor for wastewater treatment unit;

BG_{CH_4} = Fraction of carbon as CH_4 in generated biogas (default is 0.65);

QS = Waste sludge stream flow rate (m^3 /hr);

QWW= Wastewater influent flow rate (m^3 /hr);

MLVSSs = Mixed liquor volatile suspended solids concentration of the waste sludge stream (mg/L);

λ = Biomass yield (g C converted to biomass/g C consumed in the wastewater treatment process)

Treated System	***MCF***	**λ**
Treatment process		
Aerated treatment process(activated sludge system), well managed	*0*	*0.65*
Aerated treatment process, overloaded (anoxic areas)	*0.3*	*0.45*
Anaerobic treatment process(anaerobic reactor)	*0.8*	*0.1*
Facultative lagoon, shallow	*0.2*	*0*
Facultative lagoon, shallow(>2 m deep)	*0.8*	*0*
Sludge treatment		
Aerobic sludge digestion	*0*	*From waste water*
Anaerobic sludge digestion	*0*	*From waste water*

Table 4 default values for methane correction factor(mcf) and biomass yield (λ)Source :IPCC(2006)

Table 5

Correction factor used	Correction factor as per IPCC	
	BOD OR COD	TOC as methane
$CFCO_2$	1.375	3.667
$CFCH_4$	0.5	1.333
CFs	0.53	0.53
CFc	0.375	1

constant corrective factors Source IPCC(2006)

Sample collection and their testing

From both the treatment plants as per the standard test strategies. Which is situated in Dehradun and other is in the Uttarkashi. The physical and chemical parameters like pH, DO, BOD, COD,
temperature , TSS. Were calculated from both inlet and the outlet and from this BOD is used to calculate the carbon dioxide and the methane from the sewage treatment plant one is SBR and the other one is MBBR.

Sample collected and tested in Dehradun and the various values iscalculated from the 20MLDSewage treatment plant:

Below the areas pictures are shown from the inlet and the outlet in the Uttarkashi as first picture used is the picture of the Dehradun 20 MLD plant from the inlet and from the outlet and after these the picture of Uttarkashi 2MLD plant is used.

Fig.5 inlet from where the waste water sample is taken before the treatment plant

Fig.6 outlet from where the wastewater sample taken after the treatment of wastewater.

Fig.7 Reagent MnSO4 and alkalized is used at the time of taking a sample from the treatment plant.

Following reading were taken from the treatment plant in different day at different month
From 20MLD treatment plant:

Table 6 physical and chemical parameter of wastewater Treatment plant from inlet in different day

S.No	Test parameters	4/12/2019	4/01/2020	4/02/2020	15/02/2020	22/02/2020	4/03/2020	unit
1	Ph	7.41	7.38	7.37	7.38	7.45	7.32	NA
2	Total suspended	247	231	267	247	230	266	Mg/l
3	Chemical oxygen demand	328	312	296	304	296	316	Mg/l
4	Biochemical oxygen demand	147	133	127	127	133	140	Mg/l
5	temperature	16.6	17.6	16.6	16.1	17.2	16.7	Celsius
6	Dissolve d oxygen	0.2	nil	nil	0.24	nil	nil	NA

Table7 : physical and chemical parameter of wastewater treatment plant from outlet in different day.

S.NO	Test parameters	4/12/2019	4/01/2020	4/02/2020	15/02/2020	22/02/2020	4/03/2020	limit
1	Ph	7.64	7.56	7.52	7.61	7.54	7.61	6.5-9.0
2	Total suspended solid	8	9	9	7	10	7	10mg/l
3	Chemical oxygen demand	24	28	24	20	28	20	50mg/l
4	Biochemical oxygen demand	9	9	7	8	9	8	10mg/l
5	temperature	17.7	17.8	16.7	16.7	17.6	17.3	$20^{o}c$
6	Dissolved oxygen	5.8	5.2	5.8	6	6.4	5.4	NA

Sample collected and tested in Uttarkashi and the various values is calculated from the 2.0 MLD Sewage treatment plant:

Fig.8 inlet from where the wastewater taken before the treatment of wastewater

Fig.9 outlet from where the wastewater taken after the treatment of wastewater

Table 8 physical and chemical parameter of wastewater Treatment plant from inlet in different day in Uttarkashi.

S.NO	Test parameters	4/07/2019	4/08/2019	4/09/2019	15/10/2019	22/11/2019	28/11/2019	unit
1	Ph	7.12	7.83	7.93	7.83	7.95	7.95	NA
2	Total suspended soilids	145	215	218	229	203	195	Mg/l
3	Chemical oxygen demand	360	450	239	239	283	255	Mg/l
4	Biochem ical oxygen demand	140	157	150	93	132	113	Mg/l
5	temperature	16.2	16.8	16.4	16.6	16.2	16.6	Celsius
6	Dissolved oxygen	nil	0.3	nil	nil	0.42	nil	NA

Table 9 :physical and chemical parameter of wastewater treatment plant from outlet in different day**.**

S.no	Test parameters	4/07/2019	4/08/2019	4/09/2019	15/10/2019	22/11/2019	28/11/2019	limit
1	Ph	7.24	7.45	7.12	7.09	7.10	7.17	6.5-9.0
2	Total suspended solid	10	9	11	8	9	10	10mg/l
3	Chemical oxygen demand	44	45	19	18	21	21	50mg/l
4	Biochemical oxygen demand	8	9	9	8	9	9	10mg/l
5	temperature	17.1	17.6	17.2	17.4	16.8	17.8	$20^{o}c$
6	Dissolved oxygen	5.6	5.3	5.4	6.4	6.2	5.8	NA

RESULT&DISCUSSION

The release of the GHG in Dehradun and Uttarkashi is been assessed in the SBR and the MBBR of 20 MLD and 2 MLD were resolved just the on location source and this on location source. As the 20 MLD plant in Dehradun which is SBR and the other in Uttarkashi the following conclusion was made by calculating the following values on the basis of the table 3.1

However, the reading was taken in a day per month and being equivalent check and the values is calculated for Dehradun and Uttarkashi treatment plant. As the main point is that the Uttarkashi treatment plant reading was taken in 2019 for the day in different month. And the total average GHG emissions from the wastewater treatment system from the wastewater treatment process and the sludge digester in Uttarkashi are 243.90 TPY CO_2e. And the total average GHG emissions from the wastewater treatment system from the wastewater treatment process and the sludge digester in Dehradun are 293.38 TPY CO_2e. And as comparing both the unit MBBR is treated with only 2 MLD of water but the SBR treated with 20 MLD and the emission rate in TPY CO_2e per year is higher for the SBR as compared to the MBBR. If the other values is also compared. The average CO_2 emission from the waste water treatment plant in Uttarkashi per year is 24.48mgCO_2e/year and on the other side for the SBR plant in Dehradun the average CO_2 emission per year is 28.78 mg CO_2/year and we know that there is no CH_4 production in the wastewater as there takes place aerobic decomposition. And for the sludge digester in Uttarkashi MBBR plant the average value of emission of GHG per year is 202.16mgCO_2e/year but when this value is calculated for the SBR plant in Dehradun is 237.92mgCO_2e/year.

The following data is calculated from the data as shown in the below table 10 and the TPY variation along with per day is also shown in the bellow table 11.and these data are helpful in determine the treatment plant which emit the less amount of greenhouse gasses .the further the values is plotted in the graph as shown below in figure 4.1 and 4.2 in which in the x-axis the dates is plotted and in the y-axis the GHG emission in TPY per year with relate to per day is plotted and comparison is done between of the treatment units.. as we know that the emission of the methane is considerably less from the waste water treatment plant so there is no calculation and estimation of methane is done as we can see in the table 11 and table 12 that these values are nearly zero but if we look through the sludge unit there both carbon dioxide and the methane both are calculated in mgCo_2e/year and these values also calculated in tones per year as for these below the table 12 and 13 is there and for this the graph is made and both the values is now compared

Table 10 parameters taken from the Dehradun 20 MLD treatment plant.

Date	wastewater				Sludge			
	CO_2e emission in mg CO_2e/yr	CH_4 emission in mg CO_2e/yr	Total GHG emission per year	GHG Emission in tpy CO_2e	CO_2e emission in mg CO_2e/yr	CH4 Emission in mg CO_2e/yr	TotalGHG Emission per year	GHG emission in TPY CO_2e
4/12/2019	30.89	0	30.89	33.980	27.73	227.76	255.49	281.042
4/01/2019	27.11	0	27.11	29.82	23.652	199.728	223.61	245.97
4/02/2019	28.8	0	28.8	31.77	25.40	212.95	238.35	262.19
15/02/2019	26.58	0	26.58	29.24	23.652	195.34	219.73	241.70
22/02/2019	28.93	0	28.93	31.83	29.84	210.24	240.08	295.86
4/03/2019	30.29	0	30.29	33.31	26.98	223.38	250.36	308.62

This table is also made for the 2MLD wastewater treatment plant in Uttarkashi and the proper values is noted down. And on the basis of these values the comparison is made that the which treatment unit prefers and emit the less green house gasses and the graphs are made between this values and comparing all these values .For the Uttarkashi treatment unit the following values is shown in Table 11 Table 12 and 13 shows the variation in the data of the wastewater treatment system. That release Green house gasses from the wastewater treatment and sludge digester and according to these data the further graphs are made showing the variation between them. As from both the table we have normally seen that the use of the MBBR treatment plant reduces the emission of green house gasses so from this study we can conduct that we can lower the green house emission by the use of the MBBR treatment unit.

Table 11: Parameters taken from the Uttarkashi 2 MLD treatment plant.

Date	wastewater				Sludge			
	CO_{2e} emission in mgCO_{2e}/yr	CH_4 emission in mg CO_{2e}/yr	Total GHG Emission per year	GHG emission in tpy CO_{2e}	CO_{2e} emission in mgCO_2e/year	CH_4 emission in mgCO_{2e}/tea r	Total GHG Emission per year	GHG emission in tpy CO_{2e}
4/07/2019	24.79	0	24.79	27.27	23.502	182.208	205.71	225.93
4/08/2019	28.86	0	28.86	31.75	25.63	212.86	238.51	262.41
4/09/2019	28.71	0	28.71	31.58	29.89	210.24	237.13	260.84
15/10/2019	18.17	0	18.17	19.99	16.13	134.02	150.15	165.16
22/11/2019	25.39	0	25.39	27.93	23.32	186.58	209.90	230.89
28/11/2019	20.82	0	20.82	22.91	18.56	153.3	171.86	189.04

s.no	date	Total GHG in wastewater in tpy CO_2e
1	4/12/2019	315.02
2	4/01/2020	275.80
3	4/02/2019	293.96
4	15/02/2019	270.94
5	22/02/2019	295.86
6	4/03/2019	308.62

Table 12 data between total GHG emission and date for the 20MLD treatment unit

s.no	date	Total GHG in wastewater in tpy CO_2e
1	4/07/2019	253.20
2	4/08/2020	294.16
3	4/09/2019	292.42
4	15/10/2019	185.15
5	22/11/2019	258.82
6	28/11/2019	211.95

Table 13 data between total GHG emission and date for the 2MLD treatment unit

Comparison of data between the date and the GHG in tpy per year

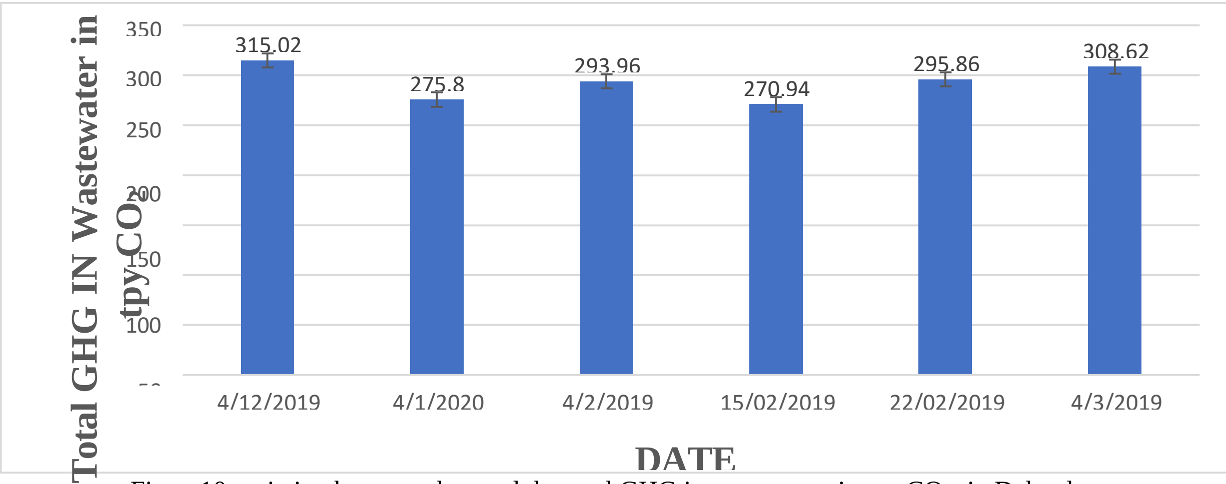

Figure10 variation between date and the total GHG in wastewater in tpy CO_{2e} in Dehradun

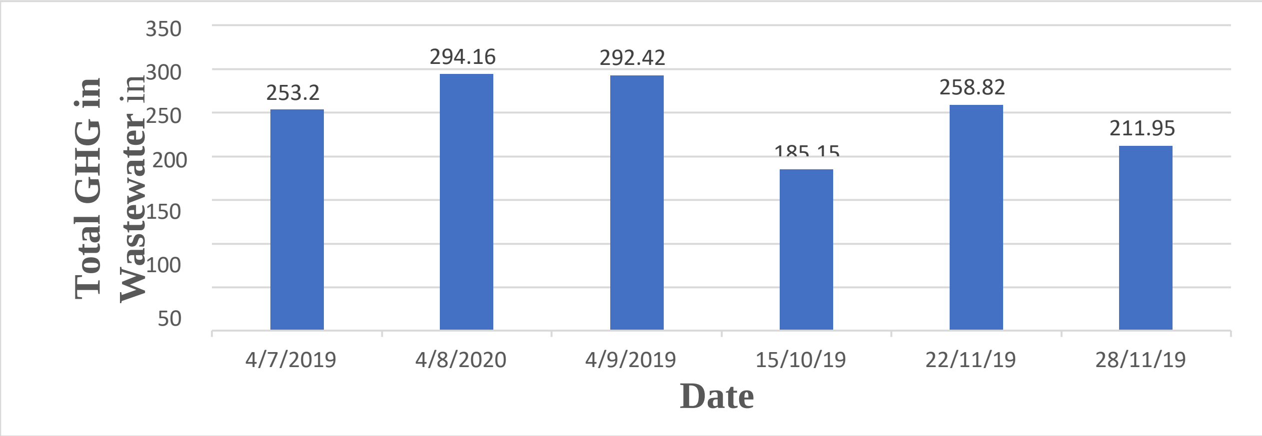

Fig.11 variation between date and the total GHG in wastewater in tpy CO_2e in Uttarkashi

CONCLUSION

The outflow of GHG from the SBR and MBBR in Dehradun and Uttarkashi. The discharges of the CO_2 and CH4 from all such treatment plants were assessed based on IPCC and RTI-USEPA rules and the all out equal was determined and broke down. And GHG were calculated and the total emission in the MBBR 2MLD is less than 18% as compared to 20MLD SBR in Dehradun and further study conclude that if we use the MBBR plant in place of the SBBR plant it will reduces the emission of green house gasses and also occupy the less area as compared to the SBR as the green house gasses plays an important role in affecting the environment .This study show that the emission of CO2 from the MBBR can be least and this MBBR performs very well and is consider as the efficient as compared to SBR in case of reduction of Green house gases.

FUTURE SCOPE

- Further this study is also used to analyzed the release of the nitrous oxide from the sewage treatment plant in MBBR and the SBR
- Achieve the good treatment process by modifying this treatment process from the MBBR and that SBR
- By varying the flow rate, MLSS the overall emission of CO_2 equivalent can bededucted
- Use of the treated water and the sludge in a proper place without affecting the environment.

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